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Screening of depression in adolescents through the Internet

Sensitivity and specificity of two screening questionnaires

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Abstract The Internet may offer new opportunities for treating depressed adolescents. However, before such treatments are possible, well-validated screening instruments are needed. In the current study, we validate two Internet-based screening instruments for depression among adolescents, the major depression inventory (MDI), and the Center for Epidemiological Studies-Depression scale (CES-D). A total of 1,392 adolescents, recruited through high schools and the Internet, filled in the online questionnaires. Of these, 243 (17%) were interviewed with the MINI diagnostic interview to assess the presence of a mood disorder. Cronbach's alpha was high for both the CES-D (0.93) and the MDI (0.88), and both correlated

highly with each other (0.88; $P < .001$). The scores on both instruments were significantly increased in all subjects with a mood disorder, whether current or lifetime, except for lifetime minor depression. In the ROC analyses, high areas under the curve were found for the MDI (0.89) and CES-D (0.90). The best cut-off point for the MDI was 19 (sensitivity: 90.48; specificity: 71.53), and for the CES-D it was 22 (sensitivity: 90.48; specificity: 74.31). We conclude that the MDI and CES-D are reliable and valid instruments that can be used for this screening.

Key words depression – adolescents – screening – sensitivity – specificity

Introduction

Depression is a highly prevalent condition among adolescents, with high recurrence rates, often poor psycho-social and academic outcomes, and an increased risk for other mental disorders [4]. Estimates of the prevalence indicate that up to 8.3% of adolescents are affected by a depressive episode, and clinically relevant depressive symptoms that do not meet criteria for major depressive disorders are found in up to 30% of adolescents [20]. By the age of 18 about one in every four adolescents has had at least one depressive episode, [7, 15] and most adults with

recurrent depression have their initial depressive episodes as teenagers [16].

Several effective treatments of depression in adolescents are available. Psychological treatment is generally considered to be the first treatment for most depressed minors [1]. Cognitive behaviour therapy has been found to be effective in several randomised trials and meta-analyses [25], but there is evidence that other types of treatments such as interpersonal psychotherapy are equally effective. However, recent research shows that the overall effects of psychological treatments in adolescents may be somewhat smaller than treatments in adults [26].

Despite the availability of effective treatments, however, undertreatment is considerable in depressed adolescents [27]. Possible causes of this undertreatment include the likelihood that adolescents tend to consider help-seeking a sign of weakness, that they do not consider their problems to be mental health problems that can be treated, they prefer to solve their problems on their own, and both parents and health professionals consider mental health problems a normal part of adolescence [27].

The Internet may offer new possibilities to treat depressed adolescents. In one study it was found that nearly one fifth (18.2%) of adolescents had sought help on the Internet for emotional problems in the previous year [11]. This suggests that the Internet may be an acceptable medium for adolescents to receive help. Furthermore, several recent studies have shown that Internet-based interventions are as effective in the treatment of depression and anxiety as more traditional types of psychological treatment [23], although most of these studies have been conducted with adults.

Before Internet-treatment for depression in adolescents is feasible, however, well-validated screening instruments are needed to identify adolescents with depression. In the past decades, several screening instruments for depression in adolescents have been developed and validated, including the Reynolds Adolescent Depression Scale (RADS) [18], child depression inventory (CDI) [24], and the Center for Epidemiological Studies-Depression scale for Children (CES-DC) [9]. However, as far as we know none of these has been validated for the use through the Internet.

In this paper, we report on a study in which two screening instruments for depression in adolescents (the Center for Epidemiological Studies-depression scale, CES-D; and the major depression inventory, MDI) were validated for the use through the Internet. These questionnaires were filled in by a large group of adolescents, and we conducted a diagnostic interview with a selection of them for the purpose of validation.

Method

■ Population

Adolescents between 14 years and 16 years of age were recruited in two ways, the first of which was through secondary schools. We stratified all 500 Dutch secondary schools by four levels of urbanization and two levels of education (lower and higher level). Sixteen randomly chosen schools, equally divided over the strata, were approached. Four of these schools were willing to participate. All 1,238 second,

third and fourth grade students were asked to participate in the study. Of these 1,238 pupils, 399 pupils and their parents (32%) gave informed consent. The second method of recruitment was directly through the Internet. A banner was put on a Dutch Internet site for school students, inviting them to participate in the study. Overall, 993 adolescents filled in the questionnaires. Recruitment took place between April and October 2005.

A selection of students (552 out of the total of 1,392) was asked to participate in a telephone interview to determine the presence of depression according to diagnostic criteria (measured with the MINI diagnostic interview, see below). The interviews took place one week after completing the screening questionnaires and were conducted by trained master-level psychology students. Twenty three percent (125) of the students refused to participate in the telephone interview, 17% of the parents refused (95) and 16% of the students (89) could not be reached. The remaining 243 adolescents were interviewed (44% of those invited, and 17% of the total sample): (1) 67 adolescents with a very low risk of depression which was defined as a CES-D score < 13 and not meeting the criteria for depression on the MDI; (2) 26 adolescents with a moderate risk of depression which was defined as a CES-D score between 13 and 15 and not meeting the criteria for depression on the MDI; (3) 149 adolescents with a high risk of depression which was defined as a CES-D score > 15 and/or meeting the criteria for depression on the MDI.

The study protocol was approved by the Medical Ethical Committee of the Free University Medical Center.

■ Screening instruments

We selected two screening instruments for further validation. The criteria used to select these instruments included the psychometric qualities of the paper-and-pencil version, understandability, usability in ethnic minority groups, and availability without additional costs.

CES-D

We used the Dutch version of the CES-D [5]. The aim of the CES-D is to screen depressive symptoms in the week preceding the screening. It is a 20-item self-report questionnaire. Each item is scored on a scale from 0 to 3 and its total score ranges from 0 (no depressive complaints at all) to 60 (many depressive complaints). The CES-D is a well-validated and much-used instrument in many studies both internationally and in the Netherlands, including studies with adolescents [5].

MDI

We used the Dutch version of the MDI [3]. The MDI measures the nine DSM-IV symptoms with 10 questions, and asks the respondent whether he or she has suffered from these symptoms in the past two weeks (ranging from not at all to all the time). The symptom concerning appetite is measured with two questions: one on increased appetite and weight gain, and one on decreased appetite and weight loss. In the DSM-IV, it is reported that a depressed mood may be expressed as agitation in adolescents [2]. Therefore, we added one question about agitation. The MDI scores can be calculated in two different ways. First it can be used as an indication for the presence of a major depressive disorder according to diagnostic criteria. For this purpose, the MDI items are dichotomised to indicate the presence or absence of each of the symptoms [3]. Major depression is defined according to the DSM-IV. Second, the MDI can be used to calculate a total score ranging from 0 to 50 by adding up the items. The MDI has good psychometric qualities in adults, but has not been validated in adolescents.

MINI diagnostic interview

As a golden standard to determine the presence or absence of a depressive disorder, we used the International Neuropsychiatric Interview (MINI), depression section. The MINI is a briefly worded structured interview to diagnose psychiatric disorders according to the DSM-IV and ICD-10 [22]. The MINI has high validity and reliability scores and has been used previously in adolescents [6, 14]. As in the MDI, we added an item about agitation.

Analyses

First, we calculated the reliability of the MDI and the CES-D (Cronbachs alpha), and the correlation between the MDI and CES-D. Then we calculated means and standard deviations for the measures and used *t*-tests to test whether the MDI and CES-D scores were associated with demographic variables.

In the subsample in which a diagnostic interview was conducted, we examined whether subjects with mood disorders scored higher than those without, on the MDI and CES-D. In these analyses, the data of the 243 subjects who were interviewed were weighted back to the proportions of the total sample of 1,392. For these tests, we also used *t*-tests.

We also calculated the sensitivity and specificity of different cut-off values at the CES-D and the MDI in detecting major depression; we performed receiver operating characteristic (ROC) analyses, and tested the equality of the MDI and the CES-D. In addition,

we determined the best cut-off point (the optimal cut-off point was the cut-off with the highest value for the sum of the square of the sensitivity and the square of the specificity). In these analyses, we also used the weighted data.

All analyses were conducted in SPSS 12.0.02, except for the ROC analyses, which were conducted in STATA/SE 8.2 (which permits testing of the equality of two different measures given a gold standard).

Because our sample consisted of two sub-samples (one recruited through schools and the other recruited through the Internet), and the depression scores differed significantly from each other in these two subsamples, we conducted most analyses both in the total sample and separately in the two subsamples.

Results

In the total population ($N = 1,238$), the reliability of the CES-D, as indicated with Cronbachs alpha was a satisfactory 0.93 (0.93 for the Internet subsample; and 0.89 for the school subsample). Cronbachs alpha was 0.82 for the MDI (0.82 in the Internet sample, and 0.75 in the school subsample). The correlation between the CES-D and the MDI scores was 0.88 ($P < .001$).

The mean on the CES-D was 13.8 (SD 11.2), and 12.1 (SD 9.7) on the MDI. In the total sample, girls, older adolescents (16–17 years), and those from ethnic minority groups had significantly higher mean CES-D scores than boys, younger adolescents (12–15 years) and native adolescents. Girls also had higher MDI-scores than boys. The results are summarized in Table 1.

Because the CES-D and MDI-scores were significantly higher in the Internet subsample ($P < 0.001$ for both scales), we also calculated the associations between the CES-D and MDI-scores and demographic characteristics in the two subsamples (Table 1). In both subsamples the CES-D and MDI scores were significantly higher in girls than in boys, and in subjects with a lower educational level (except for the MDI-score in the school subsample). In the Internet subsample, respondents from minority groups also scored significantly higher than natives.

The prevalence of current and lifetime mood disorders among the subjects who received a diagnostic interview is presented in Table 2. For each diagnostic category we tested whether their scores on the CES-D and the MDI were significantly higher than the scores in the rest of the population. As can be seen, both the CES-D and the MDI scores were significantly increased in all subjects with a mood disorder, both current and lifetime, except for lifetime minor depression and the MDI score in current minor depression.

Table 1 Means and standard deviations of the Internet-administered CES-D and MDI in adolescents recruited through schools and through the Internet

	Total sample (N = 1392)							Internet sample (N = 993)							School sample (N = 399)						
	%	CES-D			MDI			%	CES-D			MDI			%	CES-D			MDI		
		M	SD	P ^a	M	SD	P ^a		M	SD	P ^a	M	SD	P ^a		M	SD	P ^a	M	SD	P ^a
All	100	13.8	11.2		12.1	9.7		100	15.4	11.8		13.5	10.2		100	9.7	8.4		8.8	7.3	
Gender																					
Boys	52	10.7	9.4	***	9.9	8.8	***	30.1	12.6	10.4	***	11.6	9.9	***	52.1	7.8	6.7	***	7.6	6.3	***
Girls	48	15.5	11.8		13.4	9.9		69.9	16.6	12.1		14.3	10.2		47.9	11.7	9.6		10.2	8.1	
Age, years																					
12–14	31	13.4	11.5	**	12.0	10.2	n.s.	22.7	16.0	12.3	n.s.	14.2	10.8	n.s.	31.0	8.6	7.9	n.s.	8.2	7.7	n.s.
15	43	12.7	11.0		11.6	9.5		32.3	14.4	11.7		13.1	10.3		42.8	9.5	8.7		8.6	6.9	
16–17	26	14.9	11.2		12.7	9.5		45.0	15.8	11.5		13.3	9.8		26.2	11.1	8.5		9.9	7.5	
Ethnicity																					
Natives	86	12.9	10.7	***	11.3	9.1	***	79.9	14.4	11.2	***	12.5	9.7	***	85.6	9.4	8.3	n.s.	8.6	7.0	n.s.
Minorities	24	17.6	12.8		15.7	11.1		20.1	19.3	13.3		17.2	11.2		14.4	11.5	8.9		10.4	8.9	
Educational level																					
Lower	51	13.9	11.6	n.s.	12.4	10.4	n.s.	26.8	16.4	12.4	*	14.7	11.3	*	51.8	10.6	9.4	*	9.4	8.2	n.s.
Higher	49	13.4	10.9		11.7	9.1		73.2	14.7	11.3		12.7	9.5		48.2	8.8	7.2		8.2	6.3	

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$ ^aThe P indicates whether the subpopulation differs significantly from the rest of the population

We conducted the same analyses in two subsamples (Table 2). In the Internet subsample, only the subjects with a current major depressive disorder scored significantly higher on the CES-D and the MDI, while in the school subsample those with a current or lifetime major depressive disorder, and those with a current or lifetime mood disorder had a significantly increased score on the CES-D and MDI.

Next, we calculated ROC curves for the CES-D and MDI, with current major depressive disorder as the golden standard (Fig. 1). For both scales high areas

under the curve were found (for the total sample): 0.89 for the MDI (95% CI: 0.82–0.95), and 0.90 for the CES-D (95% CI: 0.84–0.95). A test of the equality of the two measures to assess the presence of major depression indicated no significant difference between the two tests ($P > 0.05$). The ROC-curves are presented in Fig. 1. The sensitivity and specificity of different cut-off scores are presented in Table 3.

The best cut-off point for the MDI was 19 (sensitivity: 90.48; specificity: 71.53), and for the CES-D it was 22 (sensitivity: 90.48; specificity: 74.31).

Table 2 Means and standard deviations of the CES-D and MDI in mood disorders

	Total sample (N = 243)							Internet sample (N = 44)							School sample (N = 199)						
	%	CES-D			MDI			%	CES-D			MDI			%	CES-D			MDI		
		M	SD	P	M	SD	P		M	SD	P	M	SD	P		M	SD	P	M	SD	P
Total population	100	13.1	11.2		11.3	9.3		100	29.0	11.3		23.5	9.1		100	9.6	7.5		8.6	6.9	
No mood disorder																					
Current	92.7	11.7	9.9		10.3	8.4		72.1	27.2	10.2		22.4	8.3		97.5	9.2	7.2		8.3	6.7	
Lifetime	78.7	11.9	10.9		10.2	9.0		67.4	29.5	12.2		23.8	9.3		81.4	8.7	6.9		7.7	8.1	
Minor depression																					
Current	2.2	23.0	8.6	*	17.8	6.7	n.s.	6.8	27.7	9.3	n.s.	20.3	7.2	n.s.	1.0	17.6	4.1	o	14.8	6.2	n.s.
Lifetime	11.8	13.4	8.6	n.s.	12.4	8.2	n.s.	11.4	25.0	8.5	n.s.	19.7	8.8	n.s.	12.1	11.0	6.6	n.s.	10.9	7.4	n.s.
Major depression																					
Current	4.2	36.8	12.8	***	29.7	9.6	***	18.2	39.3	13.5	**	31.4	10.2	**	1.0	28.6	6.7	***	24.2	5.8	***
Lifetime	9.5	22.4	11.9	***	19.3	9.6	***	22.7	29.2	10.2	n.s.	24.4	9.0	n.s.	7.0	17.5	10.8	***	15.7	8.5	***
Dysthymia																					
Current ^b	1.8	28.7	13.5	**	21.8	9.2	*	7.1	28.5	15.4	n.s.	21.1	10.3	n.s.	0.5	29.5	^d	^d	24.5	^d	^d
Any mood disord.																					
Current	7.3	30.4	12.6	***	24.3	10.1	***	29.5	33.1	13.2	n.s.	25.9	10.6	n.s.	2.5	23.1	7.8	***	20.0	8.0	***
Lifetime ^c	21.3	17.4	11.1	**	15.5	9.4	***	32.6	27.8	9.6	n.s.	22.8	8.9	n.s.	18.6	13.4	8.8	**	12.6	8.1	***

^aThe data of the 243 subjects who were interviewed were weighted back to the proportions of the total sample of 1,392^bLifetime dysthymia was not measured^cExcluding lifetime dysthymia^dBecause only one subject met criteria for dysthymia, SD and p could not be calculated

We also calculated ROC curves for the CES-D and MDI in the two subsamples. In the school subsample, the areas under the curve were somewhat higher than in the total sample (0.91 for the MDI, 95% CI: 0.86–0.97; 0.94 for the CES-D, 95% CI: 0.89–0.98). In the Internet subsample, the areas under the curve were somewhat lower (MDI: 0.78; 95% CI: 0.63–0.93; CES-D: 0.76; 95% CI: 0.61–0.92). The areas under the curve for the MDI and CES-D did not differ significantly from each other ($P > 0.05$), both within the Internet subsample and within the school subsample.

The best cut-off points in the school subsample were 22 for the CES-D (sensitivity: 100; specificity: 87.04) and 19 for the MDI (sensitivity: 100; specificity: 84.26), and in the Internet subsample 37 for the CES-D (sensitivity: 68.75; specificity: 86.11), and 31 for the MDI (sensitivity: 68.75; specificity: 88.89).

We calculated ROC curves in which the presence of any mood disorder was used as the golden standard (only for the total sample). The areas under the curve were somewhat smaller compared to major depression as a golden standard (0.82 for the MDI, 95% CI: 0.75–0.88; and 0.85; 95% CI: 0.79–0.90). The areas under the curve for the MDI and CES-D did not differ significantly from each other ($P > 0.05$).

We calculated the sensitivity and specificity of the algorithm of the MDI for a major depressive disorder, with major depressive disorder according to the MINI as the golden standard. The sensitivity was 57.14, and the specificity 91.40. As a measure of agreement between the two instruments we used the kappa statistic,

which was found to be 0.41, indicating a moderate agreement [13].

Discussion

We conducted one of the first validation studies of screening instruments for depression in adolescents, administered through the Internet. The adolescents were recruited through schools and through the Internet. Both instruments examined—the CES-D and the MDI—proved to be reliable and valid instruments and had good sensitivity and specificity compared to a diagnosis of depression based on a diagnostic interview. No indication was found that one of the two instruments was better than the other one in identifying depressive disorders.

We also found differences in outcomes for the two subsamples. The Internet subsample scored higher on the depression measures than the school sample, which seems plausible because subjects in the Internet subsample actively visited the website where they could fill in the questionnaire. Subjects suffering from depression can be assumed to be more inclined to do this. Support for this hypothesis was found in the higher prevalence rates of mood disorders in the Internet subsample.

The cut-off value we found for the CES-D (22) was considerably higher than the cut-off that is suggested in the manual. This may be related to the fact that this instrument was administered in an open population recruited through schools and the Internet, which

Fig. 1 ROC-curves of the MDI and CES-D

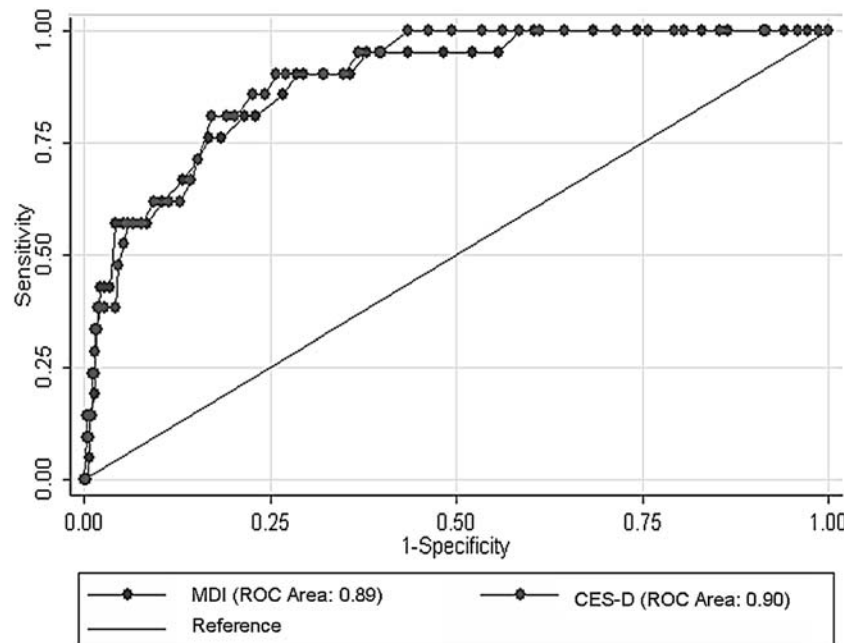


Table 3 Sensitivity and specificity of the CES-D and MDI for the total group at several cut-off points ($N = 242$)

MDI			CES-D		
Cut-off	Sensitivity	Specificity	Cut-off	Sensitivity	Specificity
9	100.00	41.67	16	100.00	56.60
10	95.24	44.44	17	95.24	60.42
11	95.24	47.92	18	95.24	63.19
12	95.24	51.74	19	90.48	65.28
13	95.24	56.60	20	90.48	68.06
14	95.24	60.07	21	90.48	72.92
15	95.24	62.15	22	90.48	74.31
16	90.48	64.24	23	85.71	75.69
17	90.48	67.71	24	85.71	77.43
18	90.48	70.49	25	80.95	79.86
19	90.48	71.53	26	80.95	80.90
20	85.71	73.26	27	80.95	82.99
21	80.95	77.08	28	71.43	84.72
22	80.95	78.47	29	66.67	85.76
23	76.19	81.60	30	61.90	87.15
24	76.19	83.33	31	61.90	88.54
25	71.43	84.72	32	61.90	90.63

may attract a somewhat different population than when a screening instrument is administered in other populations. It remains unclear, however, why and how this may have influenced the CES-D cut-off scores. In the Internet subsample the best cut-off values were even higher, but the number of diagnostic interviews we conducted in this subsample was relatively low.

The MDI seems to be a good instrument to screen for depression through the Internet. Although the qualities are comparable to those of the CES-D, the MDI has the advantage that it is considerably shorter than the CES-D (12 compared to 20 items), and requires less time input from the adolescents. The algorithm of the MDI to assess the presence of a major depressive disorder was not as good as the use of the MDI as a continuous measure of depressive

symptomatology, and it is not recommended for use in this population. These relatively low sensitivity and specificity values is also found in some other research [10], although that was conducted among adults. In a study with the MDI in adult outpatients, we also found that the MDI was superior when it was used as a continuous measure compared to the algorithm of assessing the presence of major depression [8]. It remains unsolved whether the low sensitivity and specificity are typical for adolescents or not.

As in earlier research, we found that depression is more common among girls and older adolescents than in boys and younger adolescents [12, 19, 21]. In addition, higher CES-D and MDI scores were found in ethnic minority groups compared to the native Dutch, but in minorities depression was less often diagnosed in the MINI-interview. This result was also found in another study where minorities had relatively high CES-D scores but not a higher prevalence of major depression or dysthymic disorder [17].

The results of this study should be considered in the light of its limitations. First, the response rate at schools was relatively low. We think this was caused by the procedure of getting informed consent from both the parents and adolescents. Second, we recruited a large group of adolescents through the Internet, and do not know how representative these data are. On the other hand, the instruments are specifically developed for the Internet, and this population can be assumed to be representative of adolescents who want to be screened for depression through the Internet. Third, the representativeness of the sample depends heavily on the level of access to the Internet by the adolescents, and may not be valid in other communities with other levels of access.

This study has made it clear, however, that screening for depression through the Internet is feasible and is acceptable to large groups of adolescents. Furthermore, the MDI and CES-D are reliable and valid instruments that can be used for this screening.

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